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Personality in Measurements of Photographs for the Astrographic Catalogue, at the University Observatory, Oxford. By H. H. Turner, M.A., F.R.S., Savilian Professor.

1. In the measurement of the plates for the Astrographic Catalogue at this observatory special care has been taken to eliminate systematic error of bisection. Every plate is measured twice in reversed positions (turned in its own plane through 180°), and the two measures of each star are compared. We thus obtain :—

(*a*) A check on mistakes of comparatively large amount.
(*b*) Information as to error of bisection, which affects the two measures of any star in opposite directions, and thus appears doubled in the difference.
(*c*) The elimination of the error of bisection by taking the mean of the two measures.
(*d*) Information as to the probable error of a single measure.

The main object of the present note is to show how little photographic measures are affected by error of bisection. The micrometer used here is described in *Monthly Notices*, vol. lv. p. 102, and has a scale in the focus of the eyepiece divided to $3''{\cdot}0$ and reading by estimation to $0''{\cdot}3$. It does not profess the greatest possible accuracy, but in the present paper it is shown

that the systematic errors are very small indeed ; and experience has proved that the accidental errors are much smaller than might be expected.

2. The main points of the paper may be summarised as follows, under the several paragraphs :—

§ 4. The general personality or error of bisection for a given measurer and instrument rarely exceeds $0''{\cdot}15$, or half the estimated unit. Its mean value, irrespective of sign, is $0''{\cdot}09$.

§ 5. The measurer and his instrument must be taken together. A change in either means a new personality.

§ 6. The personality remains sensibly constant for some months at least.

§ 7. The probable error of a determination of personality from a single plate (of about 200 stars) is less than $\pm 0''{\cdot}05$.

§ 8. The variation of personality with stellar magnitude is very small ; and what there is can be detected and eliminated by reversing the plate. Hence we may look to photographic measures with confidence as a means of ridding star-places of systematic error depending on magnitude of the star.

§ 10. The probable error of a single measure is about $\pm 0''{\cdot}24$, and of the mean of two, $\pm 0''{\cdot}17$; thus the results satisfy the conditions imposed by the Comité Permanent last May.

3. *Method of Reversal.*—It may be well to explain here the exact method adopted in reversing the plate. At the Royal Observatory, Greenwich, I believe both the plate and the measuring scale are rotated through 180°, so that, though the directions of measurement (both right and left and up and down) are reversed to the observer's eye, the figures recording the star's position in both coordinates are approximately the same as before. The figures printed on the eye-piece scale are read upside down, but this is a mere detail ; the estimated fraction of a division is now to the right instead of the left, or up instead of down, the same actual division being in use. At Oxford, on the other hand, the scale is not reversed, only the plate, so that if the measured coordinates of a star were in the direct position (denoted D), say 3·057 and 17·304, then in the reversed position (denoted R) they are approximately 22·943 and 8·696—*i.e.*, the differences of the former from 26·000, which is the length of a side of the measuring reseau. Suppose 22·941 and 8·697 are actually recorded in the R position. Then before comparison with the D measures, the R measures are subtracted from 26·000, giving 3·059 and 17·303 respectively. The differences of these from the D measures are then tabulated as $+{\cdot}002$ and $-{\cdot}001$ respectively, the errors of bisection being half these amounts. The method adopted at Greenwich obviates this subtraction ; but it is considered that the greater independence of the readings at Oxford is worth the extra trouble. Since two entirely different divisions of the eye-piece scale are employed at Oxford, there will also be a slight decrease of apparent accuracy, owing to the errors of scale

divisions ; but, as in other similar cases, this increase of accidental error is accompanied by a decrease of systematic error.

4. *General Personality for Different Measurers.*—To give an idea in the first instance of the kind of quantity under discussion, the following table shows the mean error of bisection (*i.e.*, *half* the mean difference R − D) for all stars on a considerable number of plates for different observers and different instruments. For the way in which the probable errors of these quantities shown in column six have been calculated see § 7. They depend, of course, on the number of plates, shown in column five.

TABLE I.

Mean Error of Bisection in Photographic Measures.

Measurer.	Inst.	Error of Bisection. Coord. x.	Coord. y.	No. of Plates.	Prob. Error of Mean.
		″	″		″
B.	α	+0·12	+0·24	17	±0·01
B.	β	+0·20	−0·03	7	±0·02
F.	β	−0·06	+0·13	36	±0·01
H.	α	−0·02	+0·02	12	±0·02
H.	β	−0·13	+0·07	10	±0·02
C.	α	−0·18	0·00	16	±0·02
C.	β	−0·12	+0·04	4	±0·03
M. H.	α	−0·09	+0·27	6	±0·02
M.	μ	−0·03	+0·06	16	±0·02

Considering that the single star places are only read off by estimation to 0″·3, these quantities are very small, although well defined, as the probable errors of the last column show. But only in four cases out of eighteen do they exceed 0″·15 (the half of a unit in the last place), and even for a plate measured by several different measurers it seems unprofitable to apply them. Only a few plates have been measured at Oxford by different measurers ; for the great majority the same measurer has measured it throughout, and thus the personality is completely eliminated. The few exceptions, measured by miscellaneous measurers at the beginning of the work, have all been re-measured by a single measurer, and thus the mean of the two sets is only affected with half such personalities as shown above.

5. *Change of Instrument.*—If the measurer changes to another instrument he must be treated as a new measurer. This is exemplified especially in the case of B. in the above table, who changed from +0″·12 to +0″·20 in x, and from +0″·24 to −0″·03 in y, when he changed from one measuring machine to another (of the same pattern). To test the reality of the change

he measured first with α, then with β, and then with α again; and it was found that he returned at once to his old personality with α. On the other hand, changing from α to β did not produce nearly such an effect on H. and C. There is nothing gained by analysing the effects of the measurer and instrument separately. They must be taken together, and if either is changed we must expect a new result.

6. *Progressive Change with Time.*—The question whether these personalities are fairly constant may be answered in the affirmative. The Oxford measurers were all new to the work, and from the analogy of transit personal-equations we should expect any change to be most marked at the beginning of the work. But at present no sensible changes have appeared. Take, for instance, F., who has a long series of plates with the same machine. Dividing his measures into groups in order of date we find

No. of Plates.	Mean Dates of Measures. D	R	x	y
			"	"
10	1896 Sept. 9	1896 Nov. 16	−·07	+·10
10	1896 Oct. 15	1896 Nov. 3	−·13	+·20
10	1897 Jan. 21	1897 Jan. 29	+·01	+·13
6	1897 Apr. 5	1897 Apr. 24	−·07	+·10

The accordance between the first and last of the series being curiously complete. It is needless to multiply instances, as the work has as yet only been going on for some months, and changes may make their appearance in the future. Meantime it seems probable that they will develop gradually, if at all.

7. *Probable Error of a Determination.*—We can thus treat a series of plates measured by the same measurer with the same instrument as homogeneous, and available without further modification for determination of probable error. Different series give *mean* errors for a single plate varying between $\pm 0''{\cdot}04$ and $\pm 0''{\cdot}07$. Thus, without making an elaborate computation, we may assume the *probable* error of a determination from a single plate to be at least as small as $\pm 0''{\cdot}06$. Dividing by the square root of the number of plates we get the results shown in the sixth column of Table I.

For illustration, the best and the worst of the different series at present available are given below. Each result refers to a whole plate, and thus depends on the measurement of (roughly speaking) 200 stars. No attempt has been made to assign different weights to the plates according to the number of stars.

Series I.

Measurer M. Inst. μ. Coordinate y.

Plate.	Error of Bisection.	Diff. from Mean.
	″	″
653	+·07	+·01
883	+·11	+·05
380	+·09	+·03
375	+·03	−·03
376	+·03	−·03
374	+·03	−·03
368	+·02	−·04
362	+·01	−·05
377	+·16	+·10
383	+·14	+·08
384	·00	−·06
784	+·10	+·04
785	+·03	−·03
250	+·08	+·02
268	+·06	·00
269	+·03	−·03
Mean	+·06	±·04

Series II.

Measurer H. Inst. β. Coordinate y.

Plate.	Error of Bisection.	Diff. from Mean.
	″	″
749	·00	−·08
750	+·05	−·03
889	−·09	−·17
412	+·10	+·02
414	·00	−·08
787	+·08	·00
788	+·14	+·06
791	+·12	+·04
300	+·30	+·22
628	+·09	+·01
Mean	+·08	±·07

The Series I. was made by a measurer* who had had considerable practice in micrometric measurement at the telescope. Series II. are the first measures of an entirely inexperienced measurer; is much shorter, and shows some evidence of progressive change, by allowing for which we could reduce the $\pm''\cdot07$ to $\pm''\cdot06$ at least. Other series fall between these extremes, and the probable error for a single plate is most likely less than $\pm''\cdot05$. The estimates in column six of Table I. are thus fairly liberal.

8. *Variation with Stellar Magnitude.*—We now come to a more important question. Is this error of bisection the same for all stars? In the case of transit-personal-equations attention has of late years been called to the fact that they vary with the brightness of the star observed. The photographic method seems to offer a means of checking such errors in meridian observations, and it has been shown by Mr. Hinks (*Monthly Notices*, vol. lvii. p. 473) how it can be used to good purpose in this way. But are measures on photographs entirely free from errors of this kind? The expedient of reversing the photograph enables us to eliminate them, even if existent; but it is more comfortable to be assured of their non-existence if possible, or at least of their smallness.

* Mr. T. J. Moore, of the Leeds Astronomical Society. It is to be remarked to his credit that micrometer μ is only a wooden model, which he thus used to very good purpose. He now has a properly made metal micrometer.

To investigate this point the measures on a number of plates have been divided into groups according to the size of disc of the star measured. The size of disc is a rough (see § 9) indication of the magnitude, nevertheless good enough for our purpose; and the results are exhibited in tabular form below.

TABLE II.

Variation of Bisection-error with Stellar Magnitude.

Measurer.	Coordinate.	Error of Bisection in Group I.	II.	III.	IV.	V.	No. of Stars in Group I.	II.	III.	IV.	V.
		″	″	″	″	″					
F.	x	−·02	−·08	−·08	+·08	+·06	453	537	216	171	18
H.	x	+·02	−·08	−·21	−·27	−·20	833	410	165	138	8
C.	x	−·18	−·23	−·17	−·08	−·29	397	402	149	146	20
M.	x	−·02	−·02	+·05	−·06	−·05	258	338	140	143	15
F.	y	+·24	+·15	·00	+·21	+·27	454	548	219	171	18
H.	y	+·05	+·11	+·08	+·08	−·17	849	395	172	153	8
C.	y	−·03	−·02	+·05	+·06	+·12	406	407	148	150	15
M.	y	+·06	+·08	+·02	+·09	+·03	245	334	137	144	13

The groups are arranged as follows :—

Group	I.	Estimated diameter of disc .	″ ″ 0·3 to 3·0
„	II.	„ „ „ .	3·3 „ 4·5
„	III.	„ „ „ .	4·8 „ 6·0
„	IV.	„ „ „ .	6·3 „ 12·0
„	V.	„ „ „ .	over 12·0

Group I. thus comprises all the faint stars, of about magnitude 11, and Group V. the bright stars of magnitude 8 and brighter.

I think it will be clear from the above table that there is nothing to be anxious about in such measures. Some measurers show an almost complete independence of stellar magnitude, as for instance M., and the largest range shown is 0″·29 (H. IV. −H. I.). It is to be remembered that even these small differences, if real, can easily be detected and also eliminated by reversal of the plate; and the hope that the photographic method offers us an escape from this troublesome error seems well grounded.

9. *The Determination of Magnitudes.*—The size of disc has been described in the preceding paragraph as a *rough* estimation of magnitude. This point cannot here be fully examined, but one or two remarks may be made. Firstly, the diameters of the discs are estimated very differently by different measurers. If all measurers estimated them alike, we should expect to find the numbers of stars in the different groups proportional to one another. But, on looking at the above Table II., it is seen that H. makes

Group I. contain twice as many as Group II. ; while others make Group II. the larger. Secondly, it is especially the fainter stars which are differently estimated. Those who have tried such estimations will recognise that for the faint stars the intensity of the patch as well as its size should be taken into account, but it is difficult to do so.

It is not without precedent that the accurate photometry of the stars should lag behind the determination of their positions ; for this has been the case all along. Positions are not only easier to determine, but more pressingly needed. As an illustration, I may refer to a paper (in No. 411 of the *Astronomical Journal*, received as I am writing), by Professor Howe on Comet 1896, VI., wherein he requires the places of 173 comparison stars. The collection of these from various sources has doubtless involved much labour, which will be considerably reduced when such measures of position as those above considered are complete. But Professor Howe does not *want* the magnitudes of the stars ; he does not even mention them in the paper.

10. *Probable Error of the Measures.*—When a plate has been measured in the two positions, and the differences of the measures formed, each difference is one of the numbers -5, -4, -3, -2, -1, 0 $+1$, $+2$, $+3$, $+4$, $+5$; the unit being $0^{r}{\cdot}001$ or $0''{\cdot}3$. Cases where the difference exceeds 5 ($=1''{\cdot}5$) are considered as due to some mistake, and *both* measures are repeated. If there is a clear mistake of say $^{r}{\cdot}010$ in one of the measures, it is altered or rejected : otherwise the mean of the four measures is taken. For the normal differences between -5 and $+5$ ($-1''{\cdot}5$ and $+1''{\cdot}5$) the number in each group is counted, giving results as follows (for an imaginary plate) :—

Plate 2386, *Measurer X.*

	-5	-4	-3	-2	-1	0	$+1$	$+2$	$+3$	$+4$	$+5$
x	1	4	17	48	35	12	4	4	2	0	0
y	0	0	4	1	10	28	37	19	12	3	1

These numbers give us both the personalities above considered, and also the probable error of a measure. Thus the mean difference in the x coordinate is :

$$(-5\times1-4\times4-3\times17-\&c.)/127=-185/127=-{\cdot}0015.$$

and in the y coordinate :

$$(-3\times4-2\times1-1\times10+1\times37+\&c.)/115=+104/115=+{\cdot}0009,$$

giving personalities of half this amount, or $-0''{\cdot}22$ in x and $+0''{\cdot}14$ in y.

To find the probable error, we should subtract this mean from each difference and sum the residuals without regard to sign or their squares. But an approximate result may be obtained with less labour by considering the mean coincident with the residual which occurs most frequently, which in the above hypothetical

case would be -2 for x and $+1$ for y. (The actual mean for y is very near $+1$; but for x it lies midway between -1 and -2, and the assumption is thus of maximum inaccuracy.) We thus consider 0 written over the 48, ± 1 over the 17 and 35, ± 2 over the 4 and 12, and so on. And the mean error in x is :

$$\pm\{(17+35)\times 1+(4+12)\times 2+(1+4)\times 3+4\times 2+2\times 3\}/127 = \pm 113/127$$
$$= \pm^{r}\cdot 0009 \text{ or } \pm 0''\cdot 27,$$

and the probable error of a single measure is taken as :

$$\pm 0''\cdot 27\times\frac{1}{\sqrt{2}}\times\cdot 85 = \pm 0''\cdot 15.$$

Similarly in y the mean error is :

$$\pm\{(28+19)\times 1+(10+12)\times 2+(1+3)\times 3+(4+1)\times 4\}/115 = 123/115$$
$$= \pm\cdot 0011 \text{ or } \pm 0''\cdot 33,$$

and the probable error of a single measure is taken as $\pm 0''\cdot 19$.

Calculated in this way we obtain the following probable errors for the different measurers :—

Measurer.	Inst.	Mean Date.	x	y	No. Stars.
			"	"	
B.	α	1896 May 16	$\pm 0''\cdot 16$	$\pm 0''\cdot 20$	730
B.	α	1896 Oct. 27	$\pm 0\cdot 22$	$\pm 0\cdot 22$	960
B.	β	1897 Jan. 10	$\pm 0\cdot 20$	$\pm 0\cdot 16$	1076
F.	β	1896 Oct. 12	$\pm 0\cdot 27$	$\pm 0\cdot 27$	700
F.	β	1897 Apr. 10	$\pm 0\cdot 20$	$\pm 0\cdot 24$	430
H.	α	1896 Nov. 19	$\pm 0\cdot 27$	$\pm 0\cdot 29$	820
H.	α	1897 Feb. 20	$\pm 0\cdot 25$	$\pm 0\cdot 19$	900
H.	β	1896 Oct. 7	$\pm 0\cdot 27$	$\pm 0\cdot 26$	830
C.	α	1896 Nov. 10	$\pm 0\cdot 29$	$\pm 0\cdot 31$	370
C.	α	1897 Jan. 20	$\pm 0\cdot 27$	$\pm 0\cdot 20$	1010
C.	β	1897 Apr. 11	$\pm 0\cdot 27$	$\pm 0\cdot 24$	660
C.	β	1897 July 8	$\pm 0\cdot 26$	$\pm 0\ 25$	1940
M. H.	α	1897 July 11	$\pm 0\cdot 26$	$\pm 0\cdot 29$	680
M.	μ	1896 Nov. 4	$\pm 0\cdot 20$	$\pm 0\cdot 20$	430
M.	μ	1897 May 31	$\pm 0\cdot 17$	$\pm 0\cdot 20$	2000
		General Mean ...	$\pm 0\cdot 24$	$\pm 0\cdot 24$	

The mean of two measures thus has a probable error $\pm 0''\cdot 24\times\cdot 71 = 0''\cdot 17$, which satisfies the conditions settled by the Comité Permanent in 1896 May.

11. Each number is derived from five plates. The groups have been selected so as to show any improvement with practice which there may be; and such improvement is in several cases manifest. In this connection it may be interesting to give

the numbers of "discordances" found among the measures of each observer per 1,000 stars, and the number of stars missed on one occasion and noted on the other. The following numbers are obtained from ten plates each; containing about 2,000 stars generally.

Measurer.	Date.	Discordances per 1000.	No. Missed in D.	No. Missed in R.
B.	Early	50	50	94
B.	Recent	54	47	79
F.	Early	100	69	65
F.	Recent	75	55	75
H.	Early	131	66	60
H.	Recent	64	38	39
C.	Early	79	46	48
C.	Recent	43	44	44
M.	Early	82	71	68
M.	Recent	98	110	77
	General Mean ...	77·6	59·6	64·9

Occultation of Ceres by the Moon on 1897 November 13, visible at Greenwich.

(*Communicated by the Superintendent of the Nautical Almanac.*)

The following particulars of an occultation of *Ceres*, as visible at Greenwich, are communicated to the Society in the hope that under favourable conditions of weather it may be possible to observe the emersion of the planet; the Moon being 19 days old and the stellar magnitude of *Ceres* being 7·5.

	G.M.T. d h m	Angle from North	Angle from Vertex.
Immersion	13 10 37	56°	99°
Emersion	13 11 30	312	355

Nautical Almanac Office,
1897 *Sept.* 14.

Catalogue No. 2, of Nebulæ discovered at the Lowe Observatory, Echo Mountain, California. By Lewis Swift.

The following list of 25 new nebulæ, follows No. 1 (of 50), discovered at this Observatory and published in *Astronomical Journal* of 1896 November 13, and also in the *Publications of the Astronomical Society of the Pacific.* Since my return to this Observatory in April last, I have devoted my time to searching for comets as well as nebulæ, for which this anomalous climate is so well adapted. The following facts will illustrate its truth. The number of clear nights in 1897 May, were 25. Rainfall 0·87 of an inch. In June, 28, rainfall 0·10. Thus far in July, 26,

precipitation 0·15. I have never seen a month when every night was clear, but in 1896 June, every one was clear with a single exception, and that was foggy. One peculiarity of the climate is that there are more clear nights than days, which is the reverse of the conditions at the Warner Observatory, Rochester, New York.

No.	Date. 1895.	R. A. 1900·0 h m s	Dec. ° ′ ″	Description.
1	Mar. 23	8 5 38	+ 5 22 45	eeeF, vS, 1E, v close f 12^m ✱, D ✱ nf points nearly to it.
2	1897. May 4	11 47 23	− 3 10 12	eF, pS, R, B ✱ f 55^s, np of 2.
3	1895. Mar. 23	11 48 33	− 3 25 15	vF, pS, R, 2 B ✱ in field, 1 n the other np.
4	23	11 48 48	− 4 34 15	eeeF, vS, 1E, a ray, in vacancy, 4 Fst in line S, 1 B and 3 Fstn.
5	1897. May 23	11 49 23	− 2 10 0	vF, vS, R, vFst near nf.
6	23	12 43 2	+54 59 45	eeF, S, cE, in field with N.G.C. 4732.
7	23	13 4 27	+53 22 48	vF, pL, R.
8	22	13 18 23	+ 6 45 16	eeeF, pS, cE, in vacancy, v dif.
9	June 25	13 47 20	+14 46 55	eeeF, pL, R, eee dif, 3^d of 4.
10	Apl. 20	13 47 38	− 0 38 0	vL, pF, cE in meridian, in field with 5334, F ✱ close to each end of major axis. See note.
11	June 2	14 46 16	+27 59 17	eeF, S, 1E, pB ✱ p, ee dif, another near suspected.
12	2	14 49 37	+16 47 5	vF, pS, R, only 1 st near, 10^m nf.
13	21	15 14 59	+ 2 8 52	vF, vE, pS, B ✱ in field n partly obscures it.
14	3	15 19 52	+13 50 10	eF, pS, vF ✱ close np.
15	21	15 30 0	+ 5 2 0	eF, pS, R, near the first of 6 or 8 st in a curved line.
16	July 22	16 18 45	+12 59 16	eeeF, S, 1E, F ✱ near f, 2 Bst in field s nearly point to it, eee dif.
17	6	19 22 0	−36 24 5	B, eS, vE, stellar, looks like close D ✱ both nebulous. Note.
18	6	19 49 10	−37 37 13	eeeF, pS, 3 st S, like belt of *Orion* point to it, eee dif.
19	6	19 53 17	−38 53 33	eeeF, S, 1E, precedes the below 37^s, ee dif, p of 2.
20	6	19 53 55	−38 53 33	eeF, pS, R, 8^m ✱ f 20^s, p of 2.
21	8	19 59 0	−48 42 25	eeeF, pS, R, F ✱ near n, ee dif, p of 2.
22	22	20 2 16	−45 55 45	vF, pS, R.
23	June 9	20 38 39	−30 16 30	eF, pS, vE, eeF ✱ and a vF ✱ near sf, point to it sp of 2.
24	9	20 38 45	−30 6 30	eeF, pS, vE, 8^m ✱ 31′n, v dif, nf of 2.
25	July 7	22 35 0	−38 33 48	vF pS, R.

Notes.

No. 10. This is a remarkable object. I have never seen one just like it. It resembles an elliptical planetary nebula. The light is evenly diffused, and the limb as sharp as a planet. Strange Sir William Herschel missed it, being so near his III. 665. Munich 9619 is 121ˢ nf.

No. 17. This also is a singular object. I have never seen but one resembling it, and that was on the same night, which I think is N.G.C. 6861. It looks like a close, bright double star, each component having a small, bright, round, star-like nebulous disc. A power of 200 failed to divide it.

The places are for 1900·0, and the year of discovery, except when otherwise noted, is 1897.

N.G.C. 6550, must be struck out, as it is identical with H, III, 555.

Lowe Observatory, Echo Mountain, California, 1897 *July* 26.

Catalogue No. 3 of Nebulæ Discovered at the Lowe Observatory, Echo Mountain, California. By Lewis Swift.

List No. 1 of 50 nebulæ discovered here was published in *Astronomical Journal* of 1896 November 13. List No 2 (of 25 nebulæ) precedes the present list, and is also published in *Publications of the Astronomical Society of the Pacific.* This, as will be seen, consists of southern nebulæ exclusively. It is a field rich in nebulæ which that mighty 'Nimrod,' Sir William Herschel, who hunted the sky over, could not reach. Several are quite bright, and a few are interesting. I have examined Gale's ring nebula, R.A. $21^h\ 53^m\ 10^s$—39° 53′ 42″ and find it an interesting one, increasing the number now known to seven. It bears considerable resemblance to the one between β and γ *Lyræ*, but is not so bright, nor will it bear magnifying like that celebrated one, though it is too far south for me to do justice to it.

Nos. 1 and 6 are singular specimens, perhaps deserving of a new classification. I have seen three lately, all appearing alike. The third will appear in list four. N. G. C. 1288 is considerably elongated in 0°. It is not round as Sir John Herschel says. Our places agree. N. G. C. 1340 must be struck out. It is identical with 1344, as has been suspected. I examined thoroughly the locality for 1340, and I am certain that it does not exist. Some time I hope to take up this matter of doubtful nebulæ.

I am glad I have at length found in Barnard's field a nebula his keen eye failed to see. See No. 24.

No.	Date 1897.		R.A. 1900·0. h m s	Dec. ° ′ ″	Description
1	Aug.	10	0 46 45	−35 0 43	fB eeS, lE ; with 132 and 200 looks like a nebulous D *Uranus.*
2	Sept.	4	0 55 0	−40 53 51	vF, vS, R.
3		4	1 9 45	−33 11 33	eeF, S, eeE, a ray, no star nr.
4		4	1 23 35	−36 17 3	eeF, pS, R. vdif.
5		4	1 33 10	−34 29 45	vF, S, R, eF ✶ nr nf.
6		6	1 46 45	−30 26 20	pB, eS, lE, like a D nebulous ✶. See No. 1.
7		6	1 53 45	−33 46 44	eeeF pS, R, 7m ✶ in field nf, another suspected.
8		4	2 6 0	−33 29 40	vF, S, vE, one ✶ nr.
9		5	2 11 0	−31 41 30	pB, pS, lE.
10		6	2 34 3	−27 52 25	pB, cS, R, 8m ✶ pretty close p.
11		5	2 44 30	−31 42 30	vF, pS, R, 1st of 3.
12		5	2 44 32	−31 36 32	pF, pS, R, 2nd of 3.
13		5	2 45 4	−31 36 32	pF, pS, lE, 3rd of 3.
14	July	22	20 19 10	−31 11 37	eF, pS, lE, wide D ✶ nr s.
15		25	20 20 50	−36 20 57	pB, vS, eE.
16	Aug.	29	20 22 0	−36 22 19	eeS, eE, in meridian.
17		29	20 24 30	−33 50 57	pF, pS, lE.
18		29	20 36 50	−30 11 30	vF, pS, R, 2 F st nr nf point to it, 1st of 3.
19		29	20 37 5	−30 11 30	eeF, cS, eE, 2nd of 3 edif, nr p ✶ of several in segment of a circle.
20		29	20 37 30	−30 1 30	eeeF, pS, vE, eedif, 3rd of 3.
21	July	9	21 26 5	−37 9 9	eF, pS, R, an e wide D ✶ f 30^s.
22	Aug.	31	22 3 5	−28 21 11	eeF, vS, vE, right angled triangle with 2F st near.
23		8	22 36 0	−45 19 15	pF, pL, R, F ✶ nr sf.
24	Sept.	4	22 51 10	−37 7 5	eeF, vS, eeeE, a ray, almost a line, np of 1459 Index Cat. Barnard.
25		4	22 52 20	−36 35 2	vF, vS, R, sf of 2.
26		4	22 52 30	−36 24 0	pB, pS, R, np of 2.
27	Aug.	8	23 13 50	−42 49 45	eeF, S, cE, f of 3, f 7599.
28		8	23 16 18	−43 3 20	eeeF. pL, R, 10m ✶ nr sp, 11m ✶ f, eeedif.
29		8	23 23 8	−42 2 0	pB, pS, R, 9m ✶ close S.
30		8	23 26 59	−45 36 18	vF, vS, R, bet 2 st, 8m ✶ sp.

Note on Observations of Venus in 1897 (January to April) *at Mr. Crossley's Observatory, Bermerside, Halifax.* By Joseph Gledhill.

Venus was carefully examined on every clear day, always long before sunset, and a list of the many markings, &c., which have been seen by observers, on the terminator near the poles and on the general surface of this planet, was prepared. It was, therefore, somewhat distressing to have to confess day by day that none of these projections, &c., on the terminator, dark or bright areas on the general surface, bright polar caps, &c., were ever seen with certainty, although the new glass gave an image of wonderful purity and sharpness. It ought, perhaps, to be said that on no occasion was the steadiness of the image at all what could have been desired.

The following notes will show the nature of the impressions actually received when the planet was examined under fairly good conditions :—

1897 January 26. 3 P.M. Cloudless sky; much motion. The full limb is brightest in the *n p* quadrant, and this brightness extends into the *s p* quadrant a good way. Terminator convex. The S. cusp is not like the N. ; it has a kind of hook or projection, while the N. cusp is flattened. The contrast between the bright portion of the full limb and the rest of the surface is very marked. The peculiar form at the S. cusp has been noticed several times lately. 4 P.M. The brightest part of the full limb is about the middle of the *n p* quadrant. The interior of the disc is much less bright than the terminator or the full limb.

January 27. 3 P.M. Cloudless. The full limb is very bright; brightest in *n p* quadrant, about the middle of it.

February 7. 4 and 5 P.M., just before and soon after sunset. The full limb is brightest in the *n p* quadrant. At the S. cusp there is a small rounded form or boss.

Observations of the Physical Features of Mars, made at Mr. Crossley's Observatory, Bermerside, Halifax, during the Opposition 1896–97. By Joseph Gledhill.

These observations were made with the 9-inch triple object glass mentioned in the following paper on *Jupiter.*

1896 December 19. $\lambda=127$. The planet was carefully examined, but the only features that could be distinctly seen and identified were a broad dark band surrounding the S. pole ending in a darker point or apex ; the faint circular patch to the W.,

Terby Sea no doubt ; and a faint, narrow, dusky curve sweeping round the E. side of Terby Sea at a distance from it about its own diameter away. This was probably Bessel Lake and Copernicus Land combined.

December 28. $\lambda=344°$. The *p* limb very bright ; the *f* limb not nearly so bright. A dusky area not far from the S. pole was badly seen ; also what was probably Knobel Sea in the *np* quadrant.

1897 January 1. $\lambda=7°$. A dusky, broad area or band lay to the N. of the S. pole and extended to nearly the centre of the disc (Herschel II. Strait, &c.), and having the three horn-like and curved projections at its N. edge just to the W. of the centre ; these are Dawes' Forked Bay and Burton Bay. Near the *f* limb lay Knobel Sea ; and, a mere faint speck, Lassell Sea in the *np* quadrant, not far from the limb. The *p* limb was not so bright, but still much brighter than the *f* limb. The S. limb was the brightest portion. The three bays were the darkest markings on the disc and were quite conspicuous.

January 2. $\lambda=344°$. The W. limb was not very bright, but much brighter than the E. or *f* limb. The S. portion of the Kaiser Sea could be seen quite up to the W. limb.

January 13. $\lambda=279°$. The one conspicuous feature was the N. portion of the Kaiser Sea. The region round the S. pole was bright (Lockyer Land, &c.). A soft warm colour lay over the regions E. and W. of the Kaiser Sea ; and a narrow dusky curve was seen round the N. pole, which was perhaps Delambre Sea. When $\lambda=231°$ there was a soft rose colour over all except the N. polar cap and the region near the W. limb. The W. limb was much brighter than the E. A dusky patch was seen just S. of the N. polar cap, and another near the W. limb where Oudemann Sea lies. The Kaiser Sea lies near the E. limb, and there is a bright narrow strip along its W. edge. When $\lambda=186°$ a dusky broad band lies across the disc to the N. of the S. pole, and there are also some faint markings to N. of it. The bright strip along the W. limb is very bright and broad, perhaps one-fourth or one-fifth of the semi-diameter. On the E. side of the disc the colour extends quite up to, or very nearly to, the limb. The W. limb is bright from pole to pole and much brighter than the E. limb. The broad band to N. of the S. pole is Maraldi Sea, &c. ; the faint markings to N. of it are Oudemann Sea, &c.

When $\lambda=230°$ there was no trace of ruddy colour on the disc, power 150 ; power 240 revealed a slight warm tint. The W. limb was not much brighter than the E., and a bright division in the dark region round the S. pole can be seen ; it is probably Burckhardt Land. A bright spot is seen just to E. of Oudemann Sea, which is probably Fontana Land.

January 14. $\lambda=188°$. A broad band lies across the disc to N. of S. pole ; it is Maraldi Sea ; the polar region to the S. of it is not bright ; the W. limb is very bright, and the E. limb less so ; there is a warm tint over the central region ; in the *nf*

quadrant Oudemann Sea is seen, and a bright circular spot just E. of it, *i.e.*, Fontana Land ; Oudemann Sea was on the central meridian about 6 P.M. The warm central tint extends quite up to the E. limb, but not to the W. limb.

January 17. $\lambda=179°$. The faint red colour does not extend up to the E. limb, and stops a good way short of the W. limb. The W. limb is brighter than the E., but not strikingly so.

$\lambda=192°$. W. limb not at all bright ; very little colour on the disc. Oudemann Sea was central about $7^h\ 35^m$.

$\lambda=237°$. A dark narrow patch lies just S. of the N. polar cap. The Kaiser Sea is near the E. limb and is faint. In the *s p* quadrant, just under the broad band and near where the N. edge of this band touches the W. limb, there is considerable ruddy colour.

$\lambda=267°$. The Kaiser Sea is dark ; no red colour on the disc ; W. limb not very bright.

January 18. $\lambda=184°$. Central region pale red ; no colour between Oudemann Sea and the E. limb ; W. limb not very bright ; Oudemann Sea in *n f* quadrant. When $\lambda=198°$ red colour was seen on both sides of Oudemann Sea ; W. limb very bright, much brighter than the E. limb ; Oudemann Sea on the central meridian about $8^h\ 12^m$. When $\lambda=257°$ Kaiser Sea was well away from the E. limb.

January 20. Nasmyth Inlet has not yet been seen this opposition ; Lassell Sea has been well seen more than once ; the dark Bessel Lake and the dark sweep to the north of it, and that to the N. of Copernicus Land, have been seen once ; Trouvelot Bay has been seen several times since 1896 December. This evening, $\lambda=193°$, the broad band to the N. of the S. pole, a faint diffuse marking between the centre and the N. pole (Oudemann Sea), and the N. polar cap are well seen. Oudemann Sea was on the central meridian about $9^h\ 20^m$. Very little ruddy colour seen on the disc.

January 21. $\lambda=193°$. The *p* limb is not very bright, and is not much brighter than the *f* limb ; very little, if any, warm colour on the disc. The region S. of Maraldi Sea is bright, and Burckhardt's Inlet is seen. A faint marking near the *p* limb is seen ; it is probably Oudemann Sea.

January 22. $\lambda=160°$. The *p* limb is very bright ; the *f* limb is not bright. There is a faint marking in the *n p* quadrant. Trouvelot Bay is near the central meridian. The region S. of the great broad band S. of the centre is bright. The N. polar cap is bright.

January 23. $\lambda=173°$. The N. polar cap is well seen ; it is small, bright, and a little brighter than the *p* limb ; the *f* limb is not bright. There is a rosy glow all over, the disc to the N. of the broad band between the S. pole and the centre. The region (polar) between this broad band and the S pole is nearly as bright as the central parts of the disc. There is a very bright spot on the S. limb some 20° to the W. of the point where a line through

the N. polar cap, and the centre of the disc would cut the S. limb; it is like a bright white bead and smaller than the N. polar cap. The dark broad band to N. of S. pole is Maraldi Sea, &c. Trouvelot Bay is seen occasionally. The bright spot just named lies on the S. edge of the broad band and just where it reaches the West limb.

January 25. $\lambda=90°$. The polar region between Maraldi Sea, &c., and the S. pole is bright. The W. limb is not very bright. When $\lambda=119°$ Maraldi Sea is very faint. No markings to the N. of Maraldi Sea can be seen distinctly.

January 26. $\lambda=82°$. The W. limb not very bright; no red colour on disc; brightness of W. limb extends beyond the N. pole. When $\lambda=126°$ the W. limb was bright yellow, not white; E. limb not so bright; Maraldi Sea very faint; the region between it and the S. pole is bluish white. The darkest marking is just well on the disc in the *s f* quadrant (Trouvelot Bay ?). The S. polar cap is seen. When $\lambda=140°$ the region near the S. pole is the brightest part; it is bluish white. Maraldi Sea and adjacent regions E. and W. are faint. The W. limb is very bright.

February 7. $\lambda=351°$. N. polar cap very bright; a faint curve is seen round the S. edge of the cap (Schrœter Land ?). Dawes' Forked Bay and Burton Bay seen as one curved horn ? Lockyer Land, very bright, in *s p* quadrant in the polar area and close to limb ? One edge of the Kaiser Sea very near the W. limb ? The *p* limb much brighter than the *f* limb.

February 9. $\lambda=91°$. The N. polar cap is well seen. The limb in the *s p* quadrant is very bright; that in the *n p* quadrant less so. The S. polar region is dusky. The width of the bright strip within the W. limb is about $\frac{1}{4}$ of the semi-diameter of the disc. A dark horn on N. edge of the broad dark band was on the central meridian about $8^h\ 35^m$.

February 16. $\lambda=286$. The N. portion of the Kaiser Sea was central about $7^h\ 51^m$. The *p* limb was bright but not very bright; the *f* limb dull. The N. polar cap was well seen. Lockyer Land, near the S. pole, was bright and bluish white. A dusky curve just S. of the N. polar cap was easily seen. Nasmyth Inlet and Lassel Sea are not seen.

February 23. $\lambda=220°$. The *p* limb is very bright, and much more so than the *f* limb. The region round the S. pole is bright, and the N. polar cap is seen, but no other markings with the exception of the broad dark band to N. of the S. pole, *i.e.*, Maraldi Sea, &c.

February 27. $\lambda=182°$. The region between Maraldi Sea and the S. pole is nearly as bright as the N. polar cap. The broad, dark band (Maraldi Sea, &c.) is darkest near the *f* limb. Nothing definite can be seen in all the region between Maraldi Sea and the N. pole. The *p* limb is very bright and the brightness extends inwards $\frac{1}{4}$ or $\frac{1}{5}$ of the radius of the planet; the *f* limb is much less bright.

March 1. $\lambda=192°$ The *p* limb is much brighter than the *f* limb. A faint line of shading is seen on S. edge of the N. polar cap.

March 8. $\lambda=86°$. The *p* limb is very bright, and the brightness extends inwards about $\frac{1}{5}$ of the semi-diameter of the planet. The only other marking is the dusky, broad band to N. of S. pole stretching all the way across the disc.

March 10. $\lambda=67°$. The *p* limb is very bright and the brightness extends inwards as on the 8th. The dark band across the disc (De la Rue Ocean, &c.) is, as it nearly always is, the most prominent feature of the disc ; the region between it and the S. pole is very bright. There is a dusky form near the centre of the disc ; Airy Sea ? And one near the *p* limb ; Knobel Sea ? The N. polar cap is bright and small.

March 13. $\lambda=68°$. Knobel Sea (?) is seen as on the 10th, but not Airy Sea. The N. polar cap is bright, so is the area near the S. pole. The *p* limb is much brighter than the *f* limb.

March 16. $\lambda=10°$. The *p* limb is bright and brighter than the *f* limb. Knobel Sea is on or near the central meridian, and is a faint, diffuse marking. The broad band to N. of the S. pole (De la Rue Ocean, &c.) is darkest near the *f* limb, and becomes pale near the *p* limb. The N. polar cap is bright. The area near the S. pole is bright.

Notes.

1896 December 19. Fair definition. December 28. Very poor seeing. 1897 January 1. Fair. January 2. Very poor. January 13. Fair ; often good for a few moments. January 14. Fair. January 17. Bad. January 18. Much motion. January 20. Fair. January 21. Violent motion. January 22. Stormy ; good definition between showers of snow. January 23. Fair. January 25. Bad. January 26. Bad. February 7. Poor. February 9. Poor. February 16. Fair. February 23. Stormy ; bad. February 27. Poor. March 1. Poor. March 8. Poor. March 10. Fair. March 13. Bad. March 16. Fair.

Observations of Jupiter and Jupiter's Satellites made at Mr. Crossley's Observatory, Bermerside, Halifax. By Joseph Gledhill.

This paper comprises the following sub-divisions :—

(*a*) A description of the principal features seen on the disc of *Jupiter* from 1896 November to 1897 June.

(*b*) Transits of dark and bright spots.

(*c*) The red spot, &c., notes and transits.

(*d*) Measures of the position of the principal dark belts.

(*e*) Measures of the breadth of dark bands and bright zones.

(*f*) Measures of dark and bright spots, &c.

(*g*) Notes on satellites and shadows during transit across *Jupiter's* disc.

(*h*) Observations of phenomena of *Jupiter's* satellites.

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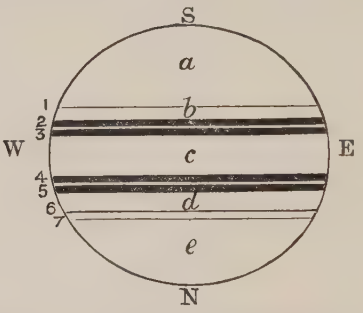
The observations were made with a 9-inch object-glass—one of the new triple lenses by Messrs. T. Cooke and Sons, York. This glass has replaced the $9\frac{1}{3}$-inch objective used for so many years at this observatory. It was expected that with this new object-glass we should obtain a purer image and see more detail on such planets as *Jupiter* and *Mars*. Nor have our expectations been unfulfilled. The instrument was turned to these planets on every fine night during the winter and spring, and the views when the definition was good certainly surpassed everything we had seen in past years with the $9\frac{1}{3}$-inch glass; the image was as pure and soft and free from colour as that given by a good reflector.

When negative eye-pieces were used the powers were 240 and 330; and a power of about 300 when the micrometer measures were made.

(*a*) *Description of the Principal Features seen on the Disc of Jupiter from* 1896 *November to* 1897 *June.*

In order to avoid confusion and save much repetition the annexed diagram is given. The dark lines represent the dark



bands or belts, and the spaces between them are the bright zones. No. 1 is the narrow strap-like dusky band, the S. temperate band; 2, 3 together form the remarkable broad dark S. equatorial belt; 4, 5 together form the broad dark N. equatorial belt, a feature nearly as conspicuous as 2, 3, and quite as interesting; 6 is a rather faint narrow band; 7 is still less dark than 6, and never seen perhaps except when the observing conditions were really good. Detached portions of a faint dark belt in the central zone (the equatorial zone) will be described, but they were rarely well seen.

a is the bright S. polar area, *b* the S. tropical zone, *c* the equatorial zone, *d* the N. tropical zone, and *e* the N. polar area.

1.

(λ is the longitude of the central meridian at the time of the observation.)

1896 November 14. $\lambda = 183°$. 1 is a narrow band, not dark.

1897 January 13. $\lambda=188°$. 1 is a faint and narrow band.

February 22. $\lambda=67°$. 1 is a faint and narrow band. As this description is of general application to 1 it will not be repeated; special departures from it alone will be noted.

March 1. $\lambda=354°$. There is a small, bright circular spot on 1; it is on the central meridian, $10^h\ 15^m$.

March 10. $\lambda=204°$. 1 is rather broad, say about the breadth of 2, 3 (taken as one belt); it is pale blue in colour.

March 13. $\lambda=19°$. A small bright, circular spot seen on 1, on the central meridian at $10^h\ 49^m$; another similar spot lies on 1 more than half way to the *p* limb. They look like satellites in transit.

March 16. $\lambda=8°$. 1 begins to grow darker a little to the W. of the *p* end of the red spot.

March 19. $\lambda=199°$. 1 is a strap-like band; well seen.

March 21. $\lambda=39°$. 1 is broad and fairly dark.

March 25. $\lambda=245°$. 1 is almost a conspicuous marking.

March 31. $\lambda=173°$. 1 is a broad, parallel-sided band and very well seen.

April 4. $\lambda=8°$. 1 begins to be darker just above the *p* end of the red spot (see March 16). $\lambda=38°$: The darker part of 1 extends from the longitude of the *p* end of the red spot to a point a little to the right of the *f* end, and then again becomes faint.

April 5. $\lambda=134°$. 1 is broader than either 2 or 3, or than either 4 or 5. λ 325° to λ 343°: The belt is narrower.

April 22. $\lambda=132°$. The preceding $\frac{1}{3}$ of 1 is darker and broader than the following $\frac{2}{3}$.

April 23. $\lambda=282°$. 1 is faint; so also when $\lambda=319°$.

April 27. $\lambda=200°$. 1 is grey.

April 28. $\lambda=349°$. The S. edge of 1 has a wavy outline; there are several small, bright, circular spots on it.

April 30. $\lambda=90°$. A small bright spot on the S. edge of 1 has passed the central meridian.

May 1. $\lambda=80°$. 1 is not well marked; darkest in middle portion. $\lambda=116°$: 1 begins to be broader and darker.

May 3. $\lambda=39°$. 1 has a darker and wider portion just above the red spot (*i.e.*, to S. of it), then faint and narrow for an equal length, and then darker up to the *f* limb. $\lambda=77°$: 1 begins to be darker and broader.

May 8. $\lambda=88°$. 1 has light and dark portions.

May 10. $\lambda=343°$. 1 is faint, except over the red spot.

2, 3.

1896 November 14. $\lambda=183°$. A very broad, brownish-yellow, double dark band; the most salient feature of the disc.

November 19. $\lambda=232°$. A double, dark band.

1897 January 13. $\lambda=188°$. The darkest and broadest band. So also on January 14; $\lambda=319°$. Dark yellow on January 17; $\lambda=34°$. On January 18, $\lambda=184°$, not dark.

January 21. $\lambda=257°$. The E. half is darker than the W. half. Dark spots on 3 when $\lambda=334°$.

January 23. $\lambda=249°$. Deep yellow in 2, 3. On January 27, $\lambda=98°$, deep yellow to brown in 2, 3.

February 23. $\lambda=199°$. Yellow colour between 2 and 3.

February 26. $\lambda=281°$. 2 and 3 nearly in contact on the W. half; on the E. half the space between them is wider, as also when $\lambda=308°$.

February 27. $\lambda=19°$. Not so dark to the left of the central meridian as to the right. When $\lambda=313°$ the place where the space between 2 and 3 begins to widen is seen.

March 1. $\lambda=239°$. 2, 3 dark yellow; 3 is darker than 2. $\lambda=310°$: The bright space between 2 and 3 begin to widen, 2 getting narrower, 3 unchanged; 2 is not so dark as 3.

March 8. $\lambda=93°$. The place where 2 and 3 begin to widen is seen; at this place 2 begins to be faint.

March 10. $\lambda=306°$. The place where the space between 2 and 3 begins to widen is on the central meridian.

March 13. $\lambda=349°$. The space between 2 and 3 is very narrow. $\lambda=304°$: The place where the space between 2 and 3 begins to widen is now on the central meridian.

March 17. $\lambda=122°$. The belt is both dark and coloured. $\lambda=240°$: 2 is a band of uniform darkness, while 3 is broken up into detached masses.

March 19. $\lambda=99°$. Deep yellow colour on 2 and 3. When $\lambda=199°$ the colour is dark yellow.

March 24. $\lambda=94°$. 2 is as dark, but not so broad, as 3.

March 31. $\lambda=173°$. 2 is not so dark nor so broad, as 3; 3 is broken up into dark cloud forms.

April 4. $\lambda=344°$. 2 is narrow. 3 is nearly as wide again as 2, and darker. $\lambda=2°$: 2 is narrower than 1. $\lambda=8°$: 3 is broken up into dark masses, which project into the central zone. There is a bright canal in 3, *i.e.* a gap in 3 connecting the bright space between 2 and 3 with the central zone.

April 5. $\lambda=134°$. There is a bright spot on 3. When $\lambda=152°$ another bright gap in 3 is seen. $\lambda=170°$: 2 and 3 are well separated, and 3 is broken up into cloud masses. $\lambda=325°$ to $343°$: 2 and 3 are seen as a uniform double band, *i.e.* not broken up or irregular, and with only a few inconspicuous cloud masses on them.

April 7. $\lambda=111°$. 2, 3, together as broad as 4; the *f* half of 2, 3 much wider than the *p* half. Cloud forms on 3 project into the central zone.

April 14. $\lambda=101°$. 2 and 3 separated all the way across the disc.

April 23. $\lambda=282°$. 2, 3 as wide as 4. Just behind (to E. of) the *f* shoulder (the great one), the bright space between 2 and 3 cuts through 3 to the central zone, like a canal running from the central zone into 2, 3, and making one dark belt into two. To the E. of the mouth of this canal 2 becomes narrower and 3 broader.

April 24. $\lambda=109°$. 2, 3 separated by a bright narrow zone all the way across the disc. So also on April 27, $\lambda=200°$, 2 being nearly as dark and broad as 3.

April 28. $\lambda=325°$. 2 becomes suddenly faint, and a bright circular spot is seen on 3.

April 30. $\lambda=257°$. 2, 3 separated. $\lambda=272°$: 2, 3, together, wider than 4, and 3 is cut through in several places. $\lambda=293°$: The place where the space between 2 and 3 widens is on the central meridian. $\lambda=307°$: 2 is narrower and paler than 3 from the *p* shoulder to the preceding limb, and gets fainter all the way up to the *p* shoulder.

May 1. $\lambda=80°$. 2, 3 separated ; dark cloud forms on 3 project into the central zone.

May 5. $\lambda=321°$. 2 is much less dark than 3 and narrower.

May 8. $\lambda=74°$. 2, 3 separated.

May 9. $\lambda=207°$. There are two bright gaps in 3, like two large eyes.

As during a good many previous oppositions, the principal features of these two broad dark bands are the great shoulder just to the E. of the red spot (called above the *f* shoulder), the less conspicuous shoulder just to the W. of the red spot (called the *p* shoulder above), and the hollow between these two shoulders. At the bottom of this hollow belt 2 has disappeared, and 3 alone remains to connect the two shoulders. At the *f* shoulder the belts 2 and 3 run into one broad dark band ; but a little to the E. the bright canal named above runs in from the central zone and converts the band into two.

4, 5.

1896 November 14. $\lambda=183°$. A narrow belt, not darker than 1. November 19. $\lambda=232°$. Very faint.

1897 January 17. $\lambda=34°$. A dark belt, consisting of detached portions six or eight in number, has been formed in the latitude of the two dark spots seen throughout the last opposition.

January 18. $\lambda=184°$. A fairly dark and sharp band ; the *p* half is detached from the *f* half, and is the darker of the two ; the *f* half has a small dark spot on it. January 21. $\lambda=257°$. There are dark spots on E. half. January 23. $\lambda=249°$. It is broken up into detached cloud forms.

January 27. $\lambda=98°$. It is narrow ; 4 is narrow and continuous ; 5 is broken up ; 5 is the darker band. The band 4 begins to fade away on the central meridian, and the zone it lies in becomes clear ; $\lambda=122°$.

February 16. $\lambda=117°$. Widely double on the W. half ; then single.

February 22. $\lambda=67°$. As broad as 2, 3 ; broken up ; the detached portions (dark cloud forms) project into the central zone.

February 23. $\lambda=118°$. Broken up (*i.e.* 5); the *p* half of 4, 5 is as broad as 2, 3; the *f* half is narrower and broken up. With $\lambda=199°$ 4 is very faint, and 5 has dark cloud forms on it, or is broken up into dark pieces.

February 26. $\lambda=308°$. Broken up; so also February 27, $\lambda=80°$.

March 1. $\lambda=239°$. 4, 5 much fainter than 2, 3; no colour (yellow) in it; broken up.

March 3. $\lambda=249°$. Broken up; bluish; as broad as 2, 3.

March 8. $\lambda=54°$. Broken up. March 9. $\lambda=72°$. Broken up; nearly as dark as 2, 3 to the E. of the central meridian. March 10.. $\lambda=186°$. Broken up and bluish. March 16. $\lambda=8°$. 4, 5 broader than 2, 3. March 17. $\lambda=122°$. 4, 5 broad, bluish, not dark. When $\lambda=240°$ broken up, and as dark as 2, 3 nearly. March 19. $\lambda=99°$. Broken up; grey. $\lambda=199°$. Grey; as wide as 2, 3. March 18. $\lambda=299°$. Same colour and width as 2, 3.

March 25. $\lambda=245°$. Broader than 2, 3; broken up.

March 29. $\lambda=162°$. Broken up; grey. March 31. $\lambda=173°$. Broken up, and as broad as 2, 3.

April 4. $\lambda=344°$. As wide as 2, 3. With $\lambda=2°$ 4, 5 is not at all a striking feature of the disc.

April 5. $\lambda=134°$. Many square-shaped cloud forms on S. edge of 4, while 5 is little disturbed. With $\lambda=325°$ the belt is double all the way across the disc. $\lambda=325°$ to $\lambda=343°$: Very little broken up, double, and as wide as 2, 3.

April 7. $\lambda=111°$. Broken up, and the dark detached portions project into the central zone. Double all the way across the disc when $\lambda=111°-120°$.

April 15. $\lambda=212°$. Two bright, small spots on the S. edge of 5. April 14. $\lambda=101°$. 4, 5 as wide as 2, 3, but not so dark. April 22. $\lambda=132°$. As wide as 2, 3.

April 23. $\lambda=282°$. Double; 4 is much broken up; 5 is but little disturbed. With $\lambda=357°$ a bright V-shaped gap is seen in 4. With $\lambda=37$ belt 4, 5 is not so dark as 2, 3. April 24. $\lambda=109°$. 4, 5 separated all the way across the disc.

April 26. $\lambda=19°$. 4, 5 double all across the disc; and the N. edge of 5 is an undulating line. In $\lambda=158°$ 4, 5 as dark as 2, 3.

April 27. $\lambda=200°$. Many cloud forms on the S. edge of 5. The belt 4, 5 is double all across the disc; dark cloud forms lie on it from the central meridian to the *f* limb, and project into the central zone.

April 28. $\lambda=325°$. 4 is cut into two parts by a narrow bright space or gap, and this place is now central; 4 is much darker than 5. There are bright spots on 5.

April 30. $\lambda=257°$. 4, 5 double all across the disc; *i.e.* they are separated by a very narrow bright space. $\lambda=309°$: The E. half of 4 is continuous; the W. half is broken up.

May 1. $\lambda=80°$ double; dark cloud-forms on S. edge of 4 and on the N. edge of 5.

May 3. $\lambda=2°$. Double all across the disc; N. edge of 5 irregular in outline. In $\lambda=2°$ to $\lambda=39°$ double; no striking cloud forms on 4 or 5. When $\lambda=77°$ a row of dark oblong spots seen on S. edge of 4.

May 5. $\lambda=321°$. The abrupt ending of 4 is approaching the central meridian; broad; double.

May 8. $\lambda=74°$. Dark spots on the S. edge of 4; double all across the disc.

May 9. $\lambda=207°$. As broad as 2, 3, and as dark. The abrupt ending of 4 was on the central meridian when $\lambda=249°$.

6.

1896 November 14. $\lambda=183°$. Broader and darker than 1 or 4, 5.

1897 January 13. $\lambda=188°$. Fairly dark. March 1. $\lambda=239°$. The short, dark portion of 6 was near the central meridian; it was on the central meridian at about $8^h\ 8^m$; its length is about one quarter the length of the whole band. March 3. $\lambda=249°$. Narrow. March 9. $\lambda=126°$. Rather wide. March 19. $\lambda=199°$. Faint and narrow. March 25. $\lambda=245°$. Difficult to see. March 31. $\lambda=173°$. Fainter and narrower than 1. April 5. $\lambda=134°$. Distinct, narrow, and darker than 1.

April 7. $\lambda=111°$. A short, darker portion of this band was on the central meridian about $9^h\ 20^m$.

April 14. $\lambda=101°$. Difficult.

April 23. $\lambda=285°$. The short, darker portion of 6 is about half-way to the central meridian. The band was very faint and narrow from 9^h to 10^h.

April 27. $\lambda=336°$. Band 6 is now fairly dark all the way across the disc.

April 28. $\lambda=325°$. The short, darker part of 6 is now mid-way between the central meridian and the *f* limb.

April 30. $\lambda=305°$. The darker short piece is now central; its length is about 6″. The band becomes very faint to E. of this darker piece.

May 1. $\lambda=80°$. Very faint. So also on May 3. $\lambda=23°$.

May 5. λ about 303°. The short, darker piece not far from the central meridian at $7^h\ 30^m$.

A faint, narrow band was also occasionally seen just to N. of 6.

Within the central coloured zone *c* portions of a faint band were seen when definition was good; *e.g.* 1897 April 27. $\lambda=181°$. A faint, dusky, narrow belt is now seen ($7^h\ 30^m$) close to the central meridian; it is nearer 3 than 4. Detached portions of it were seen all the way across the disc at $8\frac{1}{2}^h$. On May 8, at $8^h\ 48^m$, portions of this band were seen near the central meridian. And again at $8^h\ 30^m$ on May 9 it was seen nearly all the way across the disc.

The Polar Regions a and e.

Of these it is only necessary to make the remark that *a* was perhaps always nearly as bright and as free from colour as the brightest zone of the disc, viz. *b*; while *e*, the region near the N. pole beyond band 7, was often of a pale yellow colour. A few extracts from the note-book are here given :—

1896 November 14. $\lambda=183°$. "The yellowish region between 6 and the N. pole." November 19. $\lambda=232°$. "*a*, bright, no colour; *e*, a yellow region." 1897 January 13. $\lambda=188°$. "*e*, a brown region." February 16. $\lambda=117°$. "*e*, pale yellow." April 27. $8^h\ 40^m$. "The yellow colour extends from the S. edge of 2 right to the N. pole; but there is very little in zone *d*." And "from the S. edge of 2 to the S. pole there is perhaps no yellow colour." May 8. $\lambda=74°$. "The N. polar area is much more dusky than the S."; and at 9^h ($\lambda=88°$) "a pale yellow colour is spread over the N. polar area." May 9. $\lambda=211°$. "The N. polar area is as free from colour as the S."

The Bright Zones b and d.

1897 January 13. $\lambda=188°$. *b* is bright, but less so than *d*. The same on January 23; $\lambda=249°$. February 22. $\lambda=67°$. *b* is the brightest zone; so also on March 10, 17, April 7, 27, 30; May 3, 10; June 14. But *d* was the brightest on 1896 November 14, when $\lambda=183°$.

The Central (Equatorial) Bright Zone c.

This zone, with the two pairs of dark belts bounding it, was always the most salient feature, and its beautiful yellow colour added much to the effect.

1896 November 14. $\lambda=183°$. "Pale yellow gradually deepening up to band 3; it is also mottled." 1897 January 23. $\lambda=249°$. Deep yellow in and close under (to N. of) 2, 3. And at 11^h ($\lambda=98°$) on January 27, 2, 3 deep yellow to brown. March 1. $\lambda=239°$. The yellow colour gets paler from 3 to 4; is deepest just on the N. edge of 3, and stops short of 4. March 10. $\lambda=186°$. As on the 1st, no colour in the zone *c* close to the S. edge of 4. March 17. $\lambda=122°$. The deep yellow of *c* extends to the S. edge of 2 and gets paler towards 4. March 19. $\lambda=199°$. *c* and 2, 3 dark yellow. March 24. $\lambda=94°$. As on the 1st. March 31. $\lambda=173°$. *c* full of yellow colour. April 2. $\lambda=80°$. Little yellow colour in *c*. April 4. $\lambda=2°$. No yellow in the narrow zone between 2 and 3; *c* as on March 1.

April 23. $\lambda=37°$. *c*, and also 3, yellow; so also on April 24; $\lambda=109°$. April 27. $\lambda=199°$. The yellow of the zone *c* extends to and covers 2 and 3; the colour is deepest close under (to N. of) 3. April 30. $\lambda=275°$. Most of the colour is close to 3, but does not extend to 2. May 3. $\lambda=80°$. *c* is full of colour.

(b) Transits of Dark Spots on the Belts.

No well defined, isolated dark spots were seen in the bright zones, and very few on the dark belts; indeed, perhaps not one calling for any special note. The times of transit over the central meridian were noted in all cases when the definition was sufficiently good.

1896 November 14. A long dark spot or local darkening of 4, 5 was on the central meridian about $5^h\ 57^m$ A.M. On 1897 January 17, belt 4, 5 was broken up into spots or large detached portions; one was on the central meridian about $11^h\ 22^m$, another at $11^h\ 54^m$, and a third about $12^h\ 27^m$. January 18. A dark spot was seen on 4, 5 at $12^h\ 20^m$; it lay between the central meridian and the *f* limb. January 21. About $12^h\ 37^m$ one of the dark cloud forms on 4, 5 was on the central meridian; other dark detached cloud masses lay to right and left along the belt. January 23. About $11^h\ 20^m$ a dark mass was on the central meridian. February 22. $\lambda=67°$. Large dark cloud forms or spots lay along 4, 5 and projected into zone *c*. So also on February 23; one being on the central meridian about $8^h\ 47^m$, and another at $10^h\ 50^m$. February 26. $\lambda=281°$. 4, 5 a series of dark cloud forms all the way across the disc. So also on February 27; $\lambda=8°$ and $\lambda=20°$ and $\lambda=80°$. March 1. $\lambda=239°$. The dark masses lay on 4 and projected into zone *c*; one was on the central meridian about $7^h\ 49^m$, another about $8^h\ 2^m$, another at $10^h\ 47^m$. March 9. $\lambda=72°$ and $\lambda=126°$. 4, 5 was a series of dark masses. March 13. A dark mass on 4, 5 was on the central meridian about $10^h\ 15^m$. March 17. $\lambda=240°$. Dark masses on 4, 5 all along the belt and projecting into the *c* zone. So also on March 29, $\lambda=162°$; March 31, $\lambda=173°$; April 7, $\lambda=111°$. On April 23, $\lambda=285°$, 4 was broken up into dark masses projecting into the *c* zone. On April 27 a prominent cloud mass was seen on the S. edge of 4; it was on the central meridian about $7^h\ 55^m$; others lay to the E. and W. of it on 4. At about $8^h\ 34^m$ a dark, circular spot, 1″ in diameter, was seen on the S. edge of zone *b* and on the central meridian.

On May 1, about $9^h\ 5^m$, a dark form on the S. edge of 4 was on the central meridian; many others lay on the same belt; one was on the central meridian about $10^h\ 25^m$. On May 3 the first of a series of dark masses on the S. edge of 4 was on the central meridian at $9^h\ 52^m$, another at $10^h\ 29^m$. May 6, at $7\frac{1}{4}^h$, 4 was a series of dark masses. May 8. One of the dark masses on 4 was on the central meridian about $8^h\ 37^m$, another at $8^h\ 59^m$, a third about $9^h\ 47^m$, and a fourth about $10^h\ 41^m$.

The dark belts 2, 3, were less disturbed than 4, 5. 1897 February 23, at 9^h, two dark forms were seen on 3. On March 8, at $8\frac{1}{2}^h$, belt 3 was a series of detached cloud forms; so also on March 17 at 7^h.

April 4, at $8^h\ 40^m$, the detached portions of 3 projected into the *c* zone; so also on April 7 at 9^h, and on April 28 at $7\frac{1}{2}^h$, and

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May 1 at 8^h. At 8^h on May 9 two dark spots lay on 3 between the central meridian and the *f* limb; one was on the central meridian about $8^h\ 29^m$ and the other about $9^h\ 19^m$. On May 11 a dark spot on 3 was on the central meridian about $9^h\ 45^m$. On June 12, about $9^h\ 17^m$, a dark spot on 3 was on the central meridian.

Transits of Bright Spots.

1897 March 1. A small, bright, circular spot lay on the S. edge of 4 and was on the central meridian about $8^h\ 48^m$. At $10^h\ 15^m$ a similar spot on belt 1 was on the central meridian. The diameter of these spots was about 1″. March 13. A small, bright spot on belt 1, on central meridian about $10^h\ 49^m$. March 16. A small, bright spot between 2 and 3, just to E. of the central meridian, at 11^h. April 4. A bright, circular spot lay just under (to N. of) 5; on central meridian about $8^h\ 35^m$. A similar spot lay on the S. edge of 4; on central meridian about $9^h\ 12^m$.

April 5. A bright, circular spot close under 3 in bright zone *d*; on central meridian about $8^h\ 2^m$. This spot was much larger than the others.

April 15. A small, bright spot on the S. edge of 4 had just passed the central meridian at 8^h; another, on the same parallel, was on the central meridian about $8^h\ 25^m$. April 23. A bright, circular spot on belt 1 was on the central meridian about $9^h\ 7^m$. April 28. A small, bright, circular spot on 1 had passed the central meridian at $7^h\ 30^m$. Indeed, several small, bright, round spots were seen on belt 1. One on the dark belt 5 was on the central meridian about $7^h\ 45^m$. Another on the S. edge of 1 was on the central meridian at $8^h\ 10^m$. Another on the N. edge of 3 was also seen, and it was on the central meridian about $8^h\ 27^m$.

April 30. A small, bright, round spot on the S. edge of 1 had passed the central meridian at $8^h\ 15^m$. Another on the same belt was on the central meridian about $8^h\ 45^m$.

May 9. Two bright gaps in dark belt 3, looking like a pair of eyes, were a conspicuous feature at $8^h\ 9^m$. A narrow, dark strip of belt separates them; the *f* one was on the central meridian about $8^h\ 15^m$. They were seen again on May 11, and were on the central meridian about $9^h\ 18^m$.

A bright wedge, or V-shaped gap, in dark belt 4 was a conspicuous object on April 23; it was on the central meridian about $9^h\ 4^m$.

May 3. A small, bright spot on 1 was on the central meridian about $7\frac{1}{4}^h$.

(*c*) *The Red Spot, the Trough, and the two Shoulders.*

These remarkable and very permanent features call for some little notice. Of the red spot it may at once be said that, as seen here, there is no red or other distinctive colour about it, and that

'the ellipse' would be a more suitable designation. On even the best nights this wonderful object was never really well and steadily seen. The *f* end of the outline was the darkest and broadest portion; the *p* end was rarely well seen; the whole outline of the ellipse was rarely seen, owing to the faintness of the N. and S. portions. On one occasion some very faint line or marking parallel to the belts was with difficulty seen within it. The *f* end is perhaps just in contact with the great or *f* shoulder. The following transits were obtained, but with difficulty and uncertainty:—March 13, $10^h\ 51^m$; March 16, $8^h\ 22^m$; April 4, 9^h; April 16, 9^h; April 30, $10^h\ 25^m$; May 3, $7^h\ 51^m$; May 5, $9^h\ 26^m$; and May 10, $8^h\ 38^m$.

The p shoulder was on or very near the central meridian on February 27, 9^h; March 1, $10^h\ 42^m$; March 13, $10^h\ 18^m$; April 23, $9^h\ 15^m$; May 3, $7^h\ 29^m$; May 5, 9^h; May 10, $8^h\ 10^m$; April 28, $8^h\ 20^m$. *The middle of the trough* between the two shoulders was on or near the central meridian February 27, $9^h\ 18^m$; March 1, $10^h\ 55^m$; March 13, $10^h\ 45^m$; March 16, $8^h\ 15^m$; April 23, $9^h\ 40^m$.

The f or great shoulder was on or near the central meridian February 27, $9^h\ 46^m$; March 21, 8^h; April 4, $9^h\ 25^m$; April 23, $10^h\ 10^m$; April 26, $7^h\ 42^m$; April 30, $10^h\ 50^m$; May 3, $8^h\ 24^m$.

These transits were eye estimations, and none were regarded as satisfactory, owing to the bad atmospheric conditions prevailing at the time. They seem to point to a considerable change in the longitude of these features.

(*d*) *Measures of the position of the principal belts.*

The method adopted was that described in full on page 478, volume 56, of the *Monthly Notices*. The value of one revolution of the micrometer screw is, with the new 9-inch object glass, $13''\cdot525$: one division of the divided head $= 0''\cdot135$. And a power of nearly 300 was always used.

As an illustration of the values of the polar diameter of *Jupiter* obtained by measuring the distance of a dark band from the two poles, and therefore also of the degree of accuracy of the resulting latitudes of the bands, the following values of the polar diameter 1897 March 10 are given:—

1897.		Diff. from mean.	1897.		Diff. from mean.
Mar. 10	$41''\cdot9$	$0''\cdot0$	Mar. 10	$41''\cdot1$	$-0''\cdot8$
	41·5	−0·4		40·9	−1·0
	42·6	+0·7		42·5	+0·6
	42·5	+0·6		41·9	0·0
	41·9	0·0		41·7	−0·2
	42·7	+0·8			
	Mean of all $= 41''\cdot9$			Mean diff. $0''\cdot5$.	

Computed polar diameter for noon of Mar. 10 from Mr. Marth's ephemeris $= 42''\cdot2$.

Dark Band 1.

The measurements were made from the middle of this strap-like band to each pole. Column *a* gives the longitude of the central meridian, and *b* the latitude, computed by Mr. Marth's formula.

1897.	*a* °	*b* °	1897.	*a* °	*b* °
Mar. 10	295	−25	Apr. 23	319	−27
13	313	−24·8	26	85	−29·3
27	322	−27	27	217	−28·8
Apr. 8	225	−26·2	30	290	−27·6
8	243	−28·1	May 1	80	−27·2

Mean −27°·1 1895–6 −29°·4.

Dark Band 2, 3.

The measurements were made from the bright space between the two bands to each pole.

1897.	*a* °	*b* °	1897.	*a* °	*b* °
Mar. 10	295	− 8·6	Apr. 8	243	−12·0
13	313	−10·2	15	197	−12·5
16	81	−11·4	23	319	−13·1
18	309	−10·0	24	109	−10·5
19	135	− 9·7	26	19	−10·9
23	340	− 9·0	27	199	−12·7
25	281	−10·0	28	331	−11·9
27	322	−11·5	30	257	−12·3
Apr. 4	344	− 9·8	May 1	44	−12·3
4	20	−11·4	3	356	−11·1
2	80	−10·4	5	320	−11·6
8	225	− 9·7			

Mean −10°·9 1895–6 −13°·1.

Dark Band 4, 5.

1897	*a* °	*b* °	1897.	*a* °	*b* °
Mar. 10	295	+10·7	Apr. 8	225	+12·6
13	313	+ 9·3	8	243	+14·6
16	81	+13·9	15	197	+15·5
18	309	+ 9·7	23	319	+14·1
19	135	+10·3	26	85	+13·6
25	281	+11·7	28	350	[+18·3]
Apr. 2	80	+11·7	30	290	[+18·9]
4	344	+10·4	May 3	356	+12·6
4	20	+12·5	5	320	+13·8

Omitting the values in brackets, mean +12°·3. 1895–6 +8°·3.

The S. Edge of Dark Band 2.

1897.	*a*	*b*	1897.	*a*	*b*
Mar. 10	295°	−12°·8	Apr. 26	85°	−19°·9
13	313	−15·0	27	217	−19·3
25	281	−16·0	28	350	−18·2
27	322	−20·1	30	290	−18·4
Apr. 4	344	−16·5	May 1	80	−19·6
8	225	−15·7	3	5	−19·1
15	197	−17·6	5	321	−17·4
23	319	−16·9	6	75	−19·9

Mean −17°·6.

The N. Edge of Dark Band 5.

1897.	*a*	*b*	1897.	*a*	*b*
Mar. 10	295°	[+12°·0]	Apr. 26	85°	+20°·6
16	81	+18·9	27	217	+17·9
25	281	+18·5	28	350	+22·1
27	322	+16·2	30	290	+22·2
Apr. 4	344	+16·5	May 1	80	+19·6
8	243	+21·1	3	8	+19·3
15	197	+20·9	5	321	+21·7
23	319	+21·7	6	75	+19·9
24	108	+20·8			

Mean +19·°8.

A few measures on good nights were taken by placing a web so as to bisect the central zone *c*, and placing the other web tangent to the poles in succession.

March 10, $\lambda=295°$; middle of zone *c* to S. pole=21″·84 and 21″·23 to N. pole. Again, a little later, 21″·44 to S. pole and 20″·83 to N. March 18, $\lambda=309°$; 20″·96 to S. pole and 20″·55 to N. March 25, $\lambda=293°$; 20″·01 to S. pole and 20″·01 to N. March 27, $\lambda=2°$; 20″·28 to S. pole and 20″·28 to N. These measures are not reduced to mean distance.

The Faint Band in the Bright Central Zone c.

April 27, $\lambda=199°$; 19″·14 from the S. pole and 18″·39 from the N.

(*e*) *Some Measures of the Breadth of Dark Bands and Bright Zones.*

The Central Zone c.

1897.	*a*	*b* Reduced to Mean Dist.	1897.	*a*	*b* Reduced to Mean Dist.
Mar. 10	λ = 186°	width = 2″·4	Apr. 15	λ = 200°	width = 3″·7
13	304	3·8	26	20	3·2
21	39	3·5	27	200	3·1
25	281	3·0	28	349	3·2
27	2	3·0	30	254	2·3
Apr. 2	80	3·6	May 1	80	2·6
4	20	3·0	3	23	2·6
8	243	3·2	5	321	2·9

Mean 3″·0.

2, 3, *The Zone c, and* 4, 5.

1897.	*a*	*b*	1897.	*a*	*b*
Mar. 10	295°	8″·7	Apr. 24	109°	11″·2
13	358	11·1	26	86	11·0
16	356	10·9	27	200	10·7
19	184	10·2	28	350	11·3
21	39	11·0	30	290	11·3
23	340	10·4	May 1	80	11·7
27	2	10·1	3	23	11·9
Apr. 2	80	11·2	5	321	10·8
4	20	10·5	6	75	11·1
8	225	11·2	8	74	10·9
15	197	11·4	10	356	11·1
23	319	10·4			

Mean 10″·9.

Bright Zone b.

1897.	*a*	*b*		*a*	*b*
Mar. 10	294°	1″·3	Apr. 4	20°	1″·8
19	199	2·1	7	240	1·3
25	293	2·0			

Mean 1″·7.

Dark Band 1.

1897.	*a*	*b*		*a*	*b*
	°	″		°	″
Mar. 10	295	0·8	Apr. 8	243	1·1
19	183	1·2	27	181	1·3
27	127	1·0			

Mean 1″·1.

Dark Band 2, 3.

1897.	*a*	*b*		*a*	*b*
	°	″		°	″
Mar. 10	295	3·1	Apr. 8	207	3·5
13	313	3·8	8	243	3·7
16	80	3·5	15	197	4·0
19	135	3·5	23	355	4·1
19	199	4·3	26	85	3·8
21	40	4·5	30	254	4·5
25	281	3·6	May 1	80	4·6
27	322	3·6	3	21	3·9
Apr. 2	79	3·6	5	321	3·3
8	243	3·9	6	75	4·2

Mean 3″·8 1895–6 3″·5.

Dark Band 4, 5.

1897.	*a*	*b*		*a*	*b*
	°	″		°	″
Mar. 10	295	3·1	Apr. 15	197	3·7
13	313	3·4	23	355	4·1
16	80	3·5	26	85	3·8
21	40	3·2	30	254	4·3
25	281	3·9	May 1	80	4·6
Apr. 2	79	4·0	3	21	3·9
8	207	4·3	5	321	3·7
8	243	3·9	6	75	4·2
8	243	4·3			

Mean 3″·9 1895–6 2″·4.

(*f*) *Measures of Dark and Bright Spots, &c.*

A few estimates and measures of the length of the dark spots, &c., may be added here.

The dark cloud forms or the detached portions of dark band 4. May 1, $\lambda=116°$; length, 2″. May 8, $\lambda=136°$; length, $2\frac{1}{2}$″. May 9, $\lambda=237°$; length, $2\frac{1}{2}$″.

The length of the dark portion of dark band 1 just over (to S. of) the red spot, April 23, $\lambda = 31°$; length, 8″·3.

The length of the dark portion of dark band 5, April 23, $\lambda = 285°$; length, 4″·9.

The width of the mouth of the bright canal running from the central zone *c* through dark band 3, April 23, $\lambda = 285°$; width, 0″·7.

Distance of the point where 2 joins 3 from the *f* shoulder, 8″.

Distance between the *p* and *f* shoulders, $11\frac{1}{4}$″.

The small, circular, bright spots had a diameter of about 1″·0.

(*g*) *Notes on Satellites and Shadows during Transit.*

Satellite I.

1897 January 27. This satellite passed on to the disc at $9^h\ 10^m$ (*N.A.*). 10^m after ingress it was invisible, and so remained till 11^h, when clouds prevented further observation.

1897 April 22. I. Tr. E. external contact at $8^h\ 58^m$. The satellite moved along dark band 4, and was invisible till $\frac{1}{4}^h$ before egress.

Satellite II.

1897 March 1. II. Tr. I. The satellite moved along the upper (*i.e.* S.) component of the dark double belt just N. of the equator. It was faint at $8^h\ 18^m$, very faint at $8^h\ 25^m$, and invisible at $8^h\ 30^m$.

Satellite III.

1897 March 16. III. Sh. E. at $8^h\ 33^m$ (*N.A.*). The shadow seemed much larger when away from the limb than when near it. It was a very striking object on the disc till within half an hour of egress.

1897 March 23. III. Tr. I. at $6^h\ 20^m$ (*N.A.*). At 7^h and till $8^h\ 30^m$ the satellite was as black as a shadow in transit. At $9^h\ 30^m$ it was invisible. It moved along the N. component of the double dark belt just N. of the equator.

1897 April 28. III. Sh. E. at $8^h\ 24^m$ (*N.A.*). From $7\frac{1}{2}^h$ till $7\frac{3}{4}^h$ the shadow of III. was not far from the limb of *Jupiter*, and was very distinctly elongated and pear-shaped in a direction at right angles to the belts. The pointed end just touched the N. edge of the N. component of the double dark band to the N. of the equator; the wider end lay in the bright zone just N. of the dark belt.

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(*h*) *Observations of Phenomena of Jupiter's Satellites with the 9-inch Cooke Equatorial Refractor at Mr. Crossley's Observatory, Bermerside, Halifax, in* 1896–7. By Joseph Gledhill.

Day of Obs.	Satellite.	Phenomenon.	Phase.	G.M.T. of Observation.	G.M.T. of *N. Almanac.*
1897.				h m s	h m s
Jan. 18	I.	Sh. I.	Int. contact	12 14	12 10
	I.	Tr. I.	Int. contact	12 57 30	12 58
27	I.	Tr. I.	Ext. contact	9 11	9 10
Feb. 26	I.	Tr. I.	Ext. contact	10 31	10 33
			Bisection	10 32	
			Int. contact	10 33	
	I.	Sh. I.	Int. contact	10 41	10 38
27	I.	Ec. R.	First seen	10 2 48	10 3 48
			Bisection	10 4	
			Full	10 5	
	I.	Oc. D.	First contact	7 40	7 41
			Bisection	7 42	
			Gone	7 43	
Mar. 1	II.	Tr. I.	Ext. contact	7 57	7 55
			Bisection	7 59	
			Int. contact	8	
	II.	Sh. I.	Int. contact	8 17	8 13
	II.	Tr. E.	Int. contact	10 43	10 46
			Bisection	10 45	
			Ext. contact	10 47	
16	III.	Sh. E.	Int. contact	8 25	8 33
			Bisection	8 27	
			Off	8 30	
17	II.	Oc. D.	Ext. contact	7 25	7 26
Apr. 5	I.	Oc. D.	Ext. contact	10 53	10 53
			Bisection	10 54 30	
			Gone	10 56	
10	III.	Ec. R.	First seen	10 20 43	10 20 23
			Full	10 23	
22	I.	Tr. E.	Ext. contact	8 38	8 38
27	II.	Sh. E.	Int. contact	7 42?	7 48
28	III.	Sh. E.	Int. contact	8 12?	8 24
			Bisection	8 17?	
June 12	II.	Sh. I.	Int. contact	10	9 57
	II.	Tr. E.	Ext. contact	10 24	10 24
14	IV.	Sh. I.	Ext. contact	9 44	9 45
	I.	Sh. I.	Bisection	9 49 30	9 48
			Int. contact	9 51 30	

Notes.

The above are the only observations of these phenomena that were made here. The observing conditions were so bad and the clear nights so few that few observations could be made, and those of poor quality. The following summary will show that an exceptionally bad winter and spring were experienced here:—

	a		*c*	*d*	*e*	*f*	*g*
1896 Oct.	0	2	9	4	10	18	40
Nov.	0	1	10	7	13	18	52
Dec.	0	2	4	2	14	24	24
1897 Jan.	0	4	8	3	13	16	46
Feb.	0	4	4	3	11	18	28
Mar.	0	3	12	1	9	18	48
Apr.	3	3	5	0	8	14	40

a Number of really good nights. *b* Fairly good. *c* Bad.
d Clear all night. *e* Sunless days. *f* Starless nights.
g Number of clear night hours in the month.

Errata in Mr. Gledhill's paper, MONTHLY NOTICES, vol. lvi.

Page 483, line 11, *for* 218° *read* 213°.
„ „ „ 26, *for* 367°·0 *read* 267°·1.
„ 484, line 13, *for* 119°·8 *read* 122°·3.
„ 498, line 11, *for* 7°·4 *read* 8°·4.
„ „ „ 17, *for* 24°·9 *read* 25°·9.
„ „ „ 18, *for* 26°·6 *read* 20°·5.

The values of L and λ were simply approximate values, and no correction was applied for "the differences of successive values of the longitude of *Jupiter's* central meridian."

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